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Article

Chronic Obstructive Pulmonary Disease in Sweden: An intersectional multilevel analysis of individual heterogeneity and discriminatory accuracy

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ABSTRACT

Socioeconomic, ethnic and gender disparities in Chronic Obstructive Pulmonary Disease (COPD) risk are well established but no studies have applied multilevel analysis of individual heterogeneity and discriminatory accuracy (MAIHDA) within an intersectional framework to study this outcome. We study individuals at the first level of analysis and combinations of multiple social and demographic categorizations (i.e., intersectional strata) at the second level of analysis. Here we used MAIHDA to assess to what extent individual differences in the propensity of developing COPD are at the intersectional strata level. We also used MAIHDA to determine the degree of similarity in COPD incidence of individuals in the same intersectional stratum. This leads to an improved understanding of risk heterogeneity and of the social dynamics driving socioeconomic and demographic disparities in COPD incidence. Using data from 2,445,501 residents in Sweden aged 45–65, we constructed 96 intersectional strata combining categories of age, gender, income, education, civil- and migration status. The incidences of COPD ranged from 0.02% for young, native males with high income and high education who cohabited to 0.98% for older native females with low income and low education who lived alone. We calculated the intra-class correlation coefficient (ICC) that informs on the discriminatory accuracy of the categorizations. In a model that conflated additive and interaction effects, the ICC was good (20.0%). In contrast, in a model that measured only interaction effects, the ICC was poor (1.1%) suggesting that most of the observed differences in COPD incidence across strata are due to the main effects of the categories used to construct the intersectional matrix while only a minor share of the differences are attributable to intersectional interactions. We found conclusive interaction effects. The intersectional MAIHDA approach offers improved information to guide public health policies in COPD prevention, and such policies should adopt an intersectional perspective.

Introduction

Social epidemiological studies have long been criticized for the relative absence of explicit sociological theory (Krieger, 1994; Ng & Muntaner, 2014), and further integration of, and dialogue between, epidemiology and social theory has been advocated (Wemrell, Merlo, Mulinari & Hornborg, 2016). From this perspective, and following similar initiatives in the social sciences, several authors have argued for an integration of intersectionality theory within epidemiology and public health (Bauer, 2014; Bowleg, 2008; Evans, Williams, Onnela & Subramanian, 2017; Merlo, 2017; Merlo & Mulinari, 2015; Mulinari, Wemrell, Rönnerstrand, Subramanian & Merlo, 2017; Wemrell, Mulinari & Merlo, 2017b). The advantage of incorporating an intersectional framework in social epidemiology is that it goes beyond the unidimensional study of socioeconomic and demographic categorizations by considering the effect of belonging to specific strata simultaneously defined by multiple social, economic and demographic dimensions. Intersectionality theory stresses the possible existence of an interaction effect over and above the additive influence of the isolated dimensions (Bauer, 2014; Bowleg, 2008; Evans et al., 2017). In this study, we aim to apply an innovative methodological approach combining *multilevel analysis of individual heterogeneity and discriminatory accuracy* (MAIHDA) (Merlo, 2014, 2017) with an intersectional framework (Evans et al., 2017; Green, Evans & Subramanian, 2017;

Abbreviations: MAIHDA, Multilevel Analysis of Individual Heterogeneity and Discriminatory Accuracy; CI, Credible Interval; DA, Discriminatory Accuracy; ICC, Intra Class Correlation

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Wemrell, Mulinari & Merlo, 2017a). This approach may improve our understanding of both the heterogeneous distribution of risk in the population and the social dynamics driving socioeconomic and demographic disparities in health.

Chronic Obstructive Pulmonary Disease (COPD) constitutes a growing but underestimated population health challenge (GOLD, 2017) that by 2020 is predicted to become the third leading cause of death globally (Murray & Lopez, 1997). Smoking is considered the most important risk factor for COPD (GOLD, 2017). From a causal perspective, many individual level risk factors for COPD can be understood as downstream mediators of upstream social and economic determinants of health (Kaplan, 1999). While global initiatives are underway to investigate risk factors for COPD many, including smoking (Hiscock, Bauld, Amos, Fidler & Munafò, 2012), low birthweight (Brostrom, Akre, Katz-Salamon, Jaraj & Kaijser, 2013), exposure to biofuels (Po, FitzGerald & Carlsten, 2011) and hazardous particles in working environment (Boschetto et al., 2006) are differently distributed among social strata (GOLD, 2017). Whereas policy-documents may mention equity in health as an overarching aim (Schraufnagel et al., 2013; Socialstyrelsen, 2015b) the focus of clinical guidelines (GOLD, 2017) and public health strategies (Socialstyrelsen, 2015a) tend to downplay upstream interventions and little research is done on the social processes that drive disparities in COPD morbidity. Altogether, this may contribute to the image of COPD as a self-inflicted smoking related disease and increase feelings of guilt among COPD-patients (Lindqvist & Hallberg, 2010; Strang et al., 2014).

There is strong evidence that social and economic factors influence the risk of COPD (Gershon, Dolmage, Stephenson & Jackson, 2012; Schraufnagel et al., 2013; Stringhini *et al.* 2017). Most epidemiological studies consider one social categorization at a time (gender, class, civil- or migration status etc.) while the others are adjusted for. A limitation in the literature on socioeconomic disparities in health in general and on COPD risk in particular is the disregard for heterogeneity within socioeconomic categories (Gershon et al., 2012; Kanervisto et al., 2011; Miravitlles, Naberan, Cantoni & Azpeitia, 2011). Typically, studies on socioeconomic disparities in COPD-morbidity report odds ratios (ORs) (Chen, Breithaupt & Muhajarine, 2000; Marmot, Shipley, Brunner & Hemingway, 2001; Montnemery et al., 2001) or differences in prevalence (Eachus et al., 1996; Kainu et al., 2013), or other measurements of average risk differences, between social strata based on one factor at a time (e.g., income, education and occupation). This may inadvertently strengthen the belief in the effectiveness of selective interventions based on unidimensional categorizations. Indeed, some researchers suggest selective screening of COPD among people with low socioeconomic status (Dirven et al., 2013; Pleasants, Riley & Mannino, 2016). Yet it is known that measurements of average risk differences are insufficient to inform on the ability of an exposure category to discriminate individuals with an outcome from those without it. For instance, an OR that is usually considered high, for example OR = 10, can be associated with a low discriminatory accuracy (DA), due to heterogeneity within categories and overlap between categories (Merlo, Mulinari, Wemrell, Subramanian & Hedblad, 2017; Pepe, Janes, Longton, Leisenring & Newcomb, 2004). We have previously suggested that when reporting and interpreting risk factors, measures of average associations should be accompanied by analyses of heterogeneity using measures of DA, such as the area under the ROC curve or the intra-class correlation coefficient (ICC) obtained in multilevel regression modeling (Merlo, 2003, 2014, 2017; Merlo & Mulinari, 2015; Merlo, Chaix, Yang, Lynch & Råstam, 2005; Merlo et al., 2017).

As a further development of this line of research we (Merlo, 2014, 2017; Wemrell et al., 2017a) and other scholars (Evans et al., 2017; Jones, Johnston & Manley, 2016) have recently suggested the use of multilevel analysis of variance within an intersectional matrix framework. From the perspective of social epidemiology (Merlo, 2017), the intersectional MAIHDA approach can be used to evaluate the strength of intersectional strata for disease prediction. Among several conceptual and technical advantages (Evans et al., 2017; Jones et al., 2016; Merlo, 2017) the intersectional MAIHDA approach provides a feasible way of measuring multiple interactions and analysing groups of small size. By considering the social context (i.e., intersectional strata) as a higher level in the multilevel analysis, this approach also avoids the treatment of societal factors as individual level characteristics.

In the present study we apply MAIHDA to investigate an intersectional matrix that simultaneously considers different social power dimensions and therefore may improve our understanding of the socioeconomic, gendered and ethnically patterned distribution of COPD in society. Our investigation had three specific aims. First, we aimed to provide a detailed intersectional map of COPD risk in the population in order to evaluate to what extent intersectional categorizations help predict COPD at the individual level. Second, we sought to investigate whether potential differences in average incidence for COPD between intersectional strata depend on intersectional interaction or if the average risk differences are explained by the additive effects of the dimensions used to construct the intersectional matrix. Our third aim was to contribute to methodological development by applying intersectional MAIHDA in social epidemiology in general and the study of socioeconomic disparities in COPD incidence in particular.

Population and methods

Study population

The National Board of Health and Welfare, in coordination with Statistics Sweden, linked the register of the Total Swedish Population to other national databases such as the National Inpatient Register, the National Mortality Register, and the Longitudinal Integration Database for Health Insurance and Labor Market Studies (LISA), using the unique personal identification number given to each person residing in Sweden. In the data we analysed, the identification numbers were replaced with arbitrary numbers to safeguard the anonymity of the subjects. The Regional Ethics Review Board in southern Sweden as well as the data safety committees from the National Board of Health and Welfare and from Statistics Sweden approved the construction of the database used in this study.

In Fig. 1 we have visualized the selection of individuals included in the database. We restricted the population to individuals aged 45 years and older since COPD is a rare condition below that age (GOLD, 2017). To avoid the confounding effect of retirement we did not include individuals older than 65 years, which is the official age of retirement in Sweden. From 2,536,789 individuals aged 45 to 65 years and residing in Sweden at the baseline date of December, 31st 2010, we excluded 11,722 individuals who died during 2010 or 2011. We also excluded 54,161 individuals who had spent less than 5 years in Sweden to assure that the information on previous diagnosis of COPD was reliable. We also excluded 3643 individuals that emigrated during 2011 to make sure we could obtain information on incident COPD. Finally, since our study was concerned with incidence (i.e., new cases) of COPD, we excluded 21,762 individuals who received a COPD-diagnosis between 2006 and 2010. This rendered a final study sample of 2,445,501 individuals or 96% of the Swedish population in that age span.

Assessment of variables

The outcome variable was the presence or absence of a new diagnosis of COPD between January 1st, 2011 and December 31st, 2011. We defined COPD based on hospital diagnosis (visit to a hospital clinic or hospital discharge) using one of the following International Statistical Classification of Diseases and related Health Problems 10th revision (WHO, 2016) (ICD-10) codes: J40 (bronchitis, not specified as acute or chronic), J41 (simple and mucopurulent chronic bronchitis), J42 (unspecified chronic bronchitis), J43 (emphysema), or J44 (other chronic obstructive pulmonary disease).